

**1 November 2001**

***Aerospace Medicine***



***PREVENTION OF HEAT STRESS DISORDERS***

**COMPLIANCE WITH THIS PUBLICATION IS MANDATORY**

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This instruction implements AFPD 48-1, *Aerospace Medicine Program*. It establishes Air Force Flight Test Center (AFFTC) responsibilities and procedures to prevent adverse health effects of heat stress. This instruction applies to all personnel who are assigned to Edwards Air Force Base with the exception of contractor personnel. The provisions of this instruction (i.e., work rest cycles) apply to occupationally exposed workers working in outdoor hot environments. During mission essential, contingency, or emergency operations, commanders may waive the provisions of this instruction; however, when commanders waive procedures they must ensure all supervisors exercise caution, make certain all subordinate personnel are aware of heat injury symptoms, and take actions to protect the health of their personnel.

**1. Mandatory, Preferred, and Acceptable Requirements :**

- 1.1. May. Indicates an acceptable or satisfactory method of accomplishment.
- 1.2. Should. Indicates a preferred method of accomplishment.
- 1.3. Will. Indicates a mandatory requirement and is also used to express a declaration of intent, probability, or determination.

**2. Responsibilities:**

- 2.1. 95 AMDS Bioenvironmental Engineering Flight (BEF):
  - 2.1.1. Writes and maintains this instruction.
  - 2.1.2. Measures temperatures and calculates the Wet Bulb Globe Temperature (WBGT) index at intervals specified in paragraph 4.2.

2.1.3. Reports the WBGT index to the following organizations:

- 2.1.3.1. 95th Air Base Wing (ABW) Command Post.
- 2.1.3.2. 95th Support Group Security Forces Squadron.
- 2.1.3.3. 95th Civil Engineer Group Fire Department.
- 2.1.3.4. 412th Operations Support Squadron, Resource Operations Center.
- 2.1.3.5. 95th Civil Engineer Group.
- 2.1.3.6. AFFTC Information Technology Directorate.
- 2.1.3.7. 412th Test Wing.
- 2.1.3.8. AFFTC Ground Safety.
- 2.1.3.9. 716th Combined Test Force.
- 2.1.3.10. 95th Services Division.
- 2.1.3.11. Computer Sciences Corporation (Contractor).
- 2.1.3.12. MAG 46th Det B Safety Office (Marine Detachment).
- 2.1.3.13. 95th Aerospace Medicine Squadron.
- 2.1.3.14. Camp Corum (Base Human Resource Development).
- 2.1.3.15. NASA Dryden Flight Research Center.

2.1.4. Assists tenant units at remote locations in developing their supplement on heat stress, as applicable.

2.1.5. Maintains a master record of WBGT readings.

2.2. 95 AMDS Health and Wellness Center (HAWC) will educate all new base personnel on the health hazards of heat stress and prevention measures at Newcomer's Briefing during base inprocessing.

2.3. 95 AMDS Public Health Flight.

- 2.3.1. Assists in investigating heat illness incidents.
- 2.3.2. Coordinates with Edwards AFB staff personnel on discrepancies disclosed during investigation of heat stress illness incidents or other pertinent findings.

2.4. 412 OSS Weather Flight.

- 2.4.1. Measures and collects temperature and dew point readings.
- 2.4.2. Informs the following base operations centers of the Fighter Index of Thermal Stress (FITS) condition (see paragraph 5):
  - 2.4.2.1. 410 Flight Test Squadron.
  - 2.4.2.2. 411 Flight Test Squadron.
  - 2.4.2.3. 416 Flight Test Squadron.
  - 2.4.2.4. 418 Flight Test Squadron.

2.4.2.5. 419 Flight Test Squadron.

2.4.2.6. 445 Flight Test Squadron.

2.4.2.7. Test Pilot School.

2.5. Organizational and Unit Commanders:

2.5.1. Enforce activity levels for personnel in day-to-day operations and training status.

2.5.2. Acclimate workers and trainees to heat exposures (see paragraph 3).

2.5.3. Brief supervisors and workers annually on the health hazards of heat stress, the WBGT index, notification procedures, flag colors (if used), and appropriate preventive measures. This training will be documented on AF Form 55, **Employee Safety and Health Record**, for military members, and AF Form 971, **Supervisor's Employee Brief** (computer generated), for civilians.

2.5.4. Where applicable, ensure flying personnel are annually informed on how heat stress affects aircrew performance, the FITS temperature and zones, and appropriate preventive measures.

2.5.5. During training exercises, when personnel wear the ground crew chemical defense ensemble, ensure supervisors and workers are counseled concerning the early signs of heat stress and the methods to be used to minimize the effects of heat stress.

2.6. Supervisors:

2.6.1. Provide all workers or trainees under their control with information on the measures to prevent heat stress disorders, the meaning of the WBGT index, and where applicable, the warning flag colors.

2.6.2. Conduct training activities to meet the requirements of paragraph 2.5.3.

2.6.3. Plan work and rest cycles for personnel occupationally exposed to hot environments.

2.6.4. Disseminate the WBGT index to workers and trainees when informed through the notification procedures.

2.6.5. Ensure workers and trainees working outside increase their fluid intake, as stated in paragraph 7.2.

**3. Acclimatization:**

3.1. Acclimatization is a series of physiological adjustments that occur when an individual is exposed to a hot climate. A period of acclimatization is required for all personnel regardless of each individual's physical condition. The better the individual's general physical condition, the quicker acclimatization is reached. Acclimatization is achieved through progressive degrees of heat exposure and physical exertion. Acclimatization to heat begins with the first exposure and is usually developed to about 50 percent by the end of the first week. Substantial acclimatization (about 78 percent) should occur by the end of the second week. Full acclimatization is attained most quickly by gradually increasing periods of work in the heat.

3.1.1. The following are people who need acclimatization:

3.1.1.1. Individuals who are routinely and occupationally exposed to strenuous duties or heavy work need acclimatization each year. This may occur during regular duty or work as outside temperatures increase during the spring and summer.

3.1.1.2. Newly assigned personnel arriving from a cooler climate should follow the acclimatization guidelines given in para 3.1.2.

3.1.1.3. Personnel returning to work after 4 or more days of illness should undergo an abbreviated acclimatization work schedule.

3.1.2. For workers needing acclimatization, supervisors should adjust work schedules (see Table 2). The most strenuous tasks should be performed early in the morning or late in the evening with lighter duty tasks performed during the remainder of the duty day. As workers become acclimatized, work schedules can be shifted back to normal routines. When un-acclimatized workers are exposed to heat, they may experience some discomfort and signs of heat strain, such as high body temperature, increased heart rate, and fatigue on the first day. On each succeeding day, the worker's ability to perform at the same level of heat stress improves as signs of discomfort and strain diminish. During the 2 weeks a worker takes to acclimatize, he or she should be especially aware of the signs and symptoms of heat stress disorders and drink plenty of water. When discomfort and heat stress symptoms occur, workers should self-pace their activities to perform below maximum physical capacity by adjusting their work speed and interspersing brief, unscheduled, and in-place breaks. After a period of 1 to 2 weeks, a worker should be able to perform all tasks without difficulty.

#### **4. Measurement of WBGT Index :**

4.1. Bioenvironmental Engineering Flight personnel will use the WBGT formulas from the latest edition of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) and Biological Exposure Indices.

4.2. When the outside temperature is forecasted to reach 95° F during duty hours, BEF will set up the WBGT measuring device at 0730. BEF will take measurements hourly from 0800 until 1600, except as noted in section 4.4.3.

4.2.1. Bioenvironmental Engineering Flight personnel will securely place the WBGT instrument outdoors, under direct sunlight, not shielded from the wind, and at a height of approximately four feet above the ground to achieve optimum accuracy.

4.2.2. Bioenvironmental Engineering Flight personnel will make entries on a daily log.

4.2.3. Monitoring will cease during inclement weather, as determined by BEF. Bioenvironmental Engineering Flight personnel will bring equipment inside until weather conditions clear. Once weather conditions return to normal, monitoring will resume until terminated at the end of the day.

4.3. Bioenvironmental Engineering Flight personnel will perform baseline heat stress for indoor environments where personnel are occupationally exposed to hot environments. The baseline data will be validated on routine surveys. Examples of such environments are steam pits, tunnels, confined spaces heated by radiant exposure to the sun, and boiler rooms and plants.

4.4. Notification of WBGT Stages:

4.4.1. Bioenvironmental Engineering Flight personnel will accomplish notification (identified in paragraph 2.1.3.) as soon as the WBGT index reaches the first flag condition, as noted in Table 1, and when a flag condition is upgraded or downgraded to the next level.

4.4.1.1. A minimum of two (2) consecutive half-hourly readings is required before making

the notification to lower the condition. (For example, if Stage 5 is in effect, two consecutive readings below 88 °F will be required before changing the heat stress condition to Stage 4.)

4.4.2. Squadrons, upon notification from BEF, will disseminate information according to their established procedures. Squadron commanders will implement the work/rest cycle in Table A2.1 upon recommendation/ notification from BEF.

4.4.2.1. Squadron commanders may, at their discretion, use the flag system shown in Table 1, as a notification system for informing personnel of the current heat stress condition. The requirement for any system used is that all individuals be notified (by seeing the flag or other means). The commander should identify personnel responsible for putting out the flags and for changing them upon notification of change in heat stress condition.

4.4.3. If Stage 2 heat stress conditions exist at the end of the duty day (1600), shop supervisors will be required to monitor ambient temperature levels, either through thermometers located in the shop or by contacting the base weather station. When the ambient temperature drops below 95° F, the supervisor will eliminate any work/rest cycles currently in effect. If WBGT Stage 3 or higher exists at the end of the duty day, BEF will continue hourly monitoring until reaching Stage 2. At that time, notification will go out for supervisors to terminate when ambient temperatures drop below 95° F.

**Table 1. WBGT Stages, Temperature Ranges and Flag Colors.**

Stage	Temperature Range (WBGT)	Flag Color
1	< 79.9° F	(No flag required)
2	80.0 – 81.9° F	Green
3	82.0 – 84.9° F	Yellow
4	85.0 – 87.9° F	Red
5	88° F and above	Black

**Table 2. Activity Level Restrictions for Personnel**

WBGT Index	Outdoor Training/Physical Conditioning
79.9 and below (Stage 1) (No flag)	Non-acclimated: Extremely intense physical exertion may precipitate heat exhaustion or heatstroke. Use caution in conducting physical activity.  Acclimated: Normal activity.
80.0 – 81.9 (Stage 2) (Green Flag)	Non-acclimated: Use discretion in planning intense physical activity. Provide constant supervision.  Acclimated: Normal activity.
82.0 – 84.9 (Stage 3) (Yellow Flag)	Non-acclimated: Curtail strenuous exercise. Outdoor work involving physical exertion canceled. Curtail outside work details. Provide constant supervision.  Acclimated: Use discretion in planning intense physical activity. Provide constant supervision.
85.0 – 87.9 (Stage 4) (Red Flag)	Non-acclimated: Terminate all physical conditioning when 88 ×F WBGT and above. Terminate outside work details.  Acclimated: Curtail strenuous exercise. Limit physical conditioning for periods not exceeding 6 hours. Curtail outside work details.
88 and above (Stage 5) (Black Flag)	Non-acclimated or acclimated: No physical conditioning. All non-mission critical outdoor work involving physical exertion canceled.

**Note:** Curtailment means reducing the level of exertion, reducing the pace of activity, and increasing the number and length of the rest periods. (See Table A2.1 for work/rest cycles)

#### 4.5. Guidelines for Occupational Heat Exposures:

4.5.1. Personnel who routinely perform their jobs outdoors while exposed to hot environments (such as, aircraft maintenance, grounds maintenance, and repair work in steam pits and tunnels) are occupationally exposed.

4.5.2. Supervisors of occupationally exposed personnel should use Attachment 2 to plan work and rest cycles for individuals under their control. When the WBGT index reaches the tempera-

tures shown in the attachment for the category of workload, supervisors will initiate the work and rest regimen.

4.5.3. Exposures above 88° F WBGT should be allowed only when performing mission essential duties, and only then with caution.

4.5.4. When necessary to accomplish the task, two or more details should be arranged to work in sequence to ensure each crew receives the proper work and rest cycles.

4.5.5. Failure to comply with the recommended work and rest cycles may result in a notice of violation under the general duty clause section 5a(1) of the Occupational Safety and Health Act.

**5. Guidelines for Flying Personnel:** All aircrew must understand and comply with the following guidance:

5.1. General. The Fighter Index of Thermal Stress (FITS) Table (see Attachment 3) will be used to determine Normal, Caution, and Danger Zones. Base Weather (Wx) will forecast predicted zones throughout the day and post them along with the winds/temperature information on the Edwards Weather System. Base Wx will forecast the FITS values for the day and include it in the Range Planning Forecast. They will also check temperature and dew point values at every observation and determine which FITS Zone Edwards is experiencing. If the Caution or Danger zones are entered, they will disseminate a Thermal Stress Advisory over the Automated Weather Distribution System (AWDS) and notify the Supervisors of Flying (SOFs), who will ensure it is included on the Automated Terminal Information System (ATIS). Unit Operations Desks will clearly post the FITS Zone. 412 OG/CC is waiver authority for this guidance.

5.2. Hot Weather Precautions for All Aircrew:

5.2.1. All aircrew will allow time for acclimatization to hot weather and should avoid extreme efforts on the first several days of exposure.

5.2.2. When exposed to hot weather, aircrew will drink more water than thirst dictates. This will ensure proper hydration as the body increases sweat secretion to defend against heat. Aircrew should either carry water or have it readily available in the aircraft.

5.2.3. The flying squadrons listed in paragraph 2.4.2. will brief all pilots on the FITS measurement system and the appropriate preventive measures. Assistance may be obtained from 95th Aerospace Medicine Squadron.

5.3. Fighter/Trainer Aircrew Procedures: This section applies to aircrew flying 1 or 2-place, bubble canopy, high-G aircraft. For the purpose of this instruction, high-G aircraft are those capable of generating G-loading in excess of 4.0 G.

5.3.1. Caution Zone (CZ) Procedures: Limit ground operations outside an air-conditioned environment to 90 minutes maximum. If ground operations exceed 90 minutes (i.e., no flight), the aircrew must spend 60 minutes in an air-conditioned environment and re-hydrate before attempting to fly. Once a flight is completed, the aircrew must spend 60 minutes in an air-conditioned environment and re-hydrate before flying again. Do not fly with chemical defense, immersion, or arctic flight equipment while in the CZ.

5.3.2. Danger Zone (DZ) Procedures: Cancel all flights scheduled to remain below 3,000 feet AGL (low level flights/pattern-only sorties). Limit ground operations outside an air-conditioned

environment to 45 minutes maximum. T-38s are considered non air-conditioned aircraft while on the ground and must take off within the 45-minute limitation. If ground operations exceed 45 minutes (i.e., no flight), the aircrew must spend 60 minutes in an air-conditioned environment and re-hydrate before attempting to fly. Once a flight is completed, the aircrew must spend 60 minutes in an air-conditioned environment and re-hydrate before flying again. Do not fly with chemical defense, immersion, or arctic flight equipment while in the DZ.

5.3.3. Cancellation: When FITS value is greater than 115, cancel all non-essential flights.

5.4. Multiengine Jet, Reciprocating, Turboprop, and Helicopter Aircrew Procedures: Aircrew flying non-fighter/trainer aircraft will observe the following precautions when Edwards AFB is in the FITS Caution or Danger Zones.

5.4.1. If available, use cooling air during ground operations.

5.4.2. Limit ground operations outside an air-conditioned environment to no more than 3 hours. If the 3-hour limit is exceeded, aircrew must spend 30 minutes in an air-conditioned environment and re-hydrate before flying. The aircraft commander may waive the 3-hour limit based on mission requirements.

**Table 3. Heat Stress Workload Task Multiplier for MOPP 3 and 4 Conditions**

		AMBIENT TEMPERATURE		
WORK RATE	ACTIVITY EXAMPLES	20° – 49° F -7° – (-9)° C	50° – 84° F 10° – 28° C	85° – 100° F 29° – 38° C
<b>LIGHT</b>	Tower Operators Operations Officers Pilot Ground Activities Command Post Activities	1.2	1.4	1.5
<b>MODERATE</b>	Refueling Avionics Shop Aircraft Maintenance NBC Reconnaissance Team	1.3	1.4	3.0
<b>HEAVY</b>	Armament Crew Rapid Runway Repair Heavy Aircraft Repair	1.7	2.1	5.0

To estimate how much time it will take to perform a task or operation while in MOPPs 3 and 4:

1. Determine the appropriate column for the outside temperature.
2. Find the work rate using the activity examples as a guide (e.g. light, moderate, and heavy).
3. Find the task time multiplier by reading across the work rate line and down the temperature column.

**Example:** A rapid runway repair team is working while the outside temperature is 60° F. The task normally takes  $2\frac{3}{4}$  hours to complete. By using the chart, rapid runway repair is listed as a heavy work rate under the activity examples. Also, by using the outside temperature (60° F) for that work rate (heavy), the task time multiplier can be found. In this case, the task time multiplier is 2.1. Take the task time multiplier and multiply it by the time it normally takes to do the job ( $2.1 \times 2\frac{3}{4}$  hours = 5.25 hours). Therefore, the time it takes to do the job in MOPP 3 or 4 is 5° hours.

**Table 4. Heat Illness Prevention Guidelines for MOPP Level 3 and 4 Conditions**

<b>WBGT Index (°F)</b>	<b>Water Intake (in quarts/hour)</b>	<b>Work/Rest Cycle for Acclimatized Personnel (mins)</b>	<b>Activity Level For Un-acclimatized Personnel</b>
71.9 and below	at least 1/2	Continuous	Continuous
72.0 – 74.9	at least 1/2 - 1	50/10	Use discretion in planning strenuous activity
75.0 – 77.9	at least 1	45/15	When mission permits, limit strenuous exertion; avoid activity in direct sun; observe personnel for water consumption and signs of heat illness.
78.0 – 79.9	at least 1 1/2	30/30	When mission permits, curtail non-essential strenuous tasks; avoid activity in direct sun; observe personnel for water consumption and signs of heat illness.
80.0 and above	at least 2	20/40	Highest risk of heat casualties; suspend all but essential strenuous tasks to meet operational requirements; avoid activity in direct sun; observe personnel for water consumption and signs of heat illness.

**Notes:** This table was developed using guidance from Department of the Army: Unit Field Sanitation Team. FM 21-10-1, 11 Oct 89 and ACGIH TLV Booklet.

How to interpret Table 4:

- Work/rest cycle recommendations are based on personnel who are fully acclimatized, optimally conditioned, hydrated, and rested.
- Individual requirements and capabilities may vary widely. It is important to know the steps to prevent heat stress illness to compensate for these variances.
- Water intake shown supports work/rest cycles. When work/rest cycles cannot be applied due to critical mission requirements, add 1/2 to 1 more quart per hour (based on work intensity) to value in table.
- A reasonable upper limit for total consumption of water for a 12-hour workday is 12-15 quarts. The maximum sweating rate (approx. 2 quarts/hour) is higher than the maximum rate of water absorption from the gut (approx. 1.5 quarts/hour). Water overload can cause serious consequences, to include seizures and death (Hyponatremia). Whenever the table advises drinking more than 1.5 quarts per hour, plan for an extended rest and re-hydration period to make up the deficit.
- This guidance is not a substitute for common sense and experience; the appearance of heat casualties is a sure sign that the safe limit of work time has been exceeded and/or water consumption is inadequate.
- The occurrence of a heat casualty should be considered a warning that other individuals may be at immediate risk.

## **6. Guidelines for Personnel Wearing the Ground Crew Chemical Defense Ensemble:**

6.1. Personnel performing ground crew operations and training while wearing the charcoal-impregnated over-garment and associated protective equipment of the chemical defense ensemble are at increased risk of injury from heat stress. Maximum work times tolerated by personnel while they are wearing the protective ensemble are affected by factors such as an individual's physical condition, state of thermal acclimatization, and degree of hydration; the workload associated with a given task; and environmental factors, including air velocity, radiant heat (sunlight), air temperature, and humidity. WBGT criteria include many of these variables.

6.2. Measures to minimize heat casualties in personnel while they are accomplishing their mission are in AFMAN 32-4005, Personnel Protection and Attack Actions. Estimates of increases in task performance times, maximum and safe work times, and recovery rest times while personnel are wearing MOPP 3 and 4 equipment are shown in Tables 3 and 4. Commanders and supervisors should use this information when planning and conducting exercises to avoid heat injuries to their personnel.

6.3. During exercises, BEF will call the Deployment Control Center (DCC) and Command Post. The Command Post will then relay the work/rest ratios to the Battle Staff. Bioenvironmental Engineering Flight personnel will monitor until WBGT Index has reached continuous work under Table 4.

## **7. Prevention of Heat Stress Disorders.** The following subjects discuss actions to help prevent heat stress disorders.

7.1. Education. Personnel working and/or training in hot environments must be educated on the causes, symptoms, first-aid treatment, and prevention of heat disorders. The 95 AMDS Health and Wellness Center will conduct training for newly arrived personnel and during Airman Leadership School. Shop supervisors will also include heat stress awareness in annual hazard communication training, where applicable.

7.2. Water. Drink large quantities of cool water to make up for water lost through sweating. It is better to drink small amounts of water frequently (a pint every 20 minutes) to replace water than to drink large amounts less frequently.

7.2.1. Milk and coffee do not make up for water loss and should be kept to a minimum.

7.2.2. Carbonated beverages, while containing water, are not as effective as water in keeping the body hydrated because of the tendency to delay gastric emptying.

7.3. Salt. Some salt is lost in the sweat. Because the typical North American diet contains so much salt, an individual should season food to taste but should not make any additional attempts to add excessive salt to the diet. Salt tablets will not be used except under special operating environments when ordered by competent medical authority.

7.4. Clothing. Wear loose fitting clothing, especially at the neck and wrist, to allow air circulation. Wear appropriate headgear. When exposed to the sun's rays, cover yourself and apply a sun-blocking lotion to prevent sunburn. When not exposed to the sun, consideration should be given to wearing the least allowable amount of clothing.

7.5. Acclimatization. Personnel must be acclimated to heat exposures. See paragraph 3.1.

7.6. **Work Schedules.** Modify work schedules to perform the heaviest work in the coolest parts of the day. When working in hot environments, establish work and rest cycles as discussed in paragraphs 4.4.2. and Attachment 2. Take rest breaks in cool, shaded areas.

7.7. **Food.** Avoid eating greasy, fatty, or heavy foods if possible.

7.8. **Medical Treatment.** Seek medical treatment for any heat stress-related problems including rashes.

7.9. **Medications.** Any individual who works outdoors or in hot environments should inform their doctor when receiving medications. Many prescription drugs can cause the same effects as diuretics or may reduce the body's ability to sweat. These reactions can have severe affects when working outdoors and may speed the heat stress process significantly.

7.10. **Heat Syncope** is a heat stress condition caused by pooling of the blood in dilated vessels and lower extremities brought on by prolonged periods of immobile activity or standing. Selecting acclimated personnel to participate in parades and ceremonies, having them drink copious amounts of water prior to ceremony, and directing them to discreetly move arms and legs to assist the return of blood to the heart may prevent heat syncope.

**8. Recognition and First-Aid Treatment for Heat Stress Disorders.** Use Table 5 as a guide in recognizing the common heat stress disorders and as a quick reference for first aid.

**Table 5. Symptoms and First-Aid Treatment for Heat Injuries**

<b>Injury</b>	<b>Symptoms</b>	<b>First Aid</b>
Heat Syncope	Fainting with prolonged standing in the heat.	Remove to cool area. Allow to recline and provide cool water. Recovery will be prompt and complete.
Heat Cramps	Active sweating, muscle cramps	Remove to cool area. Massage extremities. Contact medical facilities.
Heat Exhaustion	Profuse sweating, headache, weakness, and nausea; skin cool and moist	Remove to cool area. Elevate feet. Loosen clothing and apply wet cloths. Evacuate to medical facility.
Heat Stroke – MEDICAL EMERGENCY	High body temperature; skin dry and hot; unconsciousness, convulsions, or delirium	THIS IS A MEDICAL EMERGENCY. Call medical facility first. Lower body temperature immediately. Remove clothing, immerse in water, if available. Otherwise, sprinkle with water and fan to increase evaporation, massage extremities, and trunk. Move to medical facility; continue cooling measures during transportation.

WILBERT D. PEARSON, JR., Brigadier General, USAF  
Commander

**Attachment 1****GLOSSARY OF REFERENCES, ABBREVIATIONS, ACRONYMS, AND TERMS*****References***

AFPD 48-1, *Aerospace Medical Program*

AFMAN 32-4005, *Personnel Protection and Attack Action*

American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) and Biological Exposure Indices

FITS developed at the USAF School of Aerospace Medicine (SAM TR-78-6, USAFSAM/VNT)

Headquarters, Department of the Army: Unit Field Sanitation Team. FM 21-10-1

***Abbreviations and Acronyms***

**ACGIH**— American Conference of Governmental Industrial Hygienist

**CZ**— Caution Zone

**DZ**— Danger Zone

**° F/° C**— Degrees Fahrenheit/Celsius

**FITS**— Fighter Index of Thermal Stress

**SOF**—Supervisor of Flying

**TLV**— Threshold Limit Values

**WBGT**— Web Bulb Globe Temperature

***Terms***

**Acclimatization**—A period of adjustment an individual's body requires to become accustomed to working in hot environments. Full acclimatization occurs through progressive degrees of heat exposure and physical exertion. Personnel may need 2 weeks of increasing exposures to become substantially acclimated and may retain most of their adaptation for about 1 week after leaving a hot climate. Workers in good physical condition acclimatize more quickly.

**Air Conditioned Environment**—1) Any air-conditioned building or vehicle; 2) The air-conditioned cockpit or cabin area of an aircraft, with cooling air supplied either externally or internally.

**Curtailment vs. Suspension of Activities**—Curtailment means reducing the level of exertion, reducing the pace of the activity and increasing the number and length of the rest periods. Suspension means to stop all strenuous activities temporarily until favorable environmental conditions return.

**Diuretic**—Diuretic compounds cause your body to lose excess water through saliva, urinating, or excess sweating. Examples of diuretics are caffeine-containing drinks such as coffee and sodas, alcohol, and water loss pills. Some prescription medications contain diuretic compounds.

**Heat Stress**—Heat stress is the combination of environmental and physical work factors that constitute the total heat load imposed on the body. The environmental heat stress factors are air temperature, radiant heat exchange (example, sunlight), air movement, and relative humidity. Physical work contributes to

total heat stress through the body's production of heat (metabolic heat) as it burns energy to sustain the work. This production of metabolic heat depends on the intensity of the physical effort that is affected, in turn, by body size, muscular development, physical fitness, and age.

**Fighter Index of Thermal Stress (FITS)**—A guideline to predict cockpit environmental conditions during low-level missions which may jeopardize aircrew performance. The FITS is based on the dry air and the dewpoint temperatures.

**Heat Stress Disorders**—Heat stress disorders are general terms used to indicate any type of adverse health problem related to heat. Heat syncope, cramps, exhaustion, and strokes are all forms of heat stress disorders. Heat stress disorders may be recognized by one or more of the following symptoms: nausea, vomiting, fever, dizziness, headache, faintness, abdominal or leg cramps, abnormal sweating, lack of coordination, mental confusion, and convulsions. The personnel most likely to be affected by the heat are those who have just arrived from cooler regions of the country, are obese, or are in poor condition.

**Heat Syncope**—Fainting while standing erect and immobile in heat, caused by pooling of the blood in dilated vessels and the lower parts of the body.

**Heat Cramps**—Painful intermittent spasms of the muscles used during work (arms, legs, or abdominal) which may occur during or after work hours. Cramps may result from exposure to high temperature for a relatively long time, particularly if accompanied by hard physical work. Cramps usually occur in unacclimated personnel after heavy sweating and are the result of excessive loss of salt from the body. Even if the moisture is replaced by drinking water, the loss of salt by sweating may provoke heat cramps.

**Heat Exhaustion**—The signs of heat exhaustion are profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. The skin is cool and sometimes pale and clammy with sweat; however, the body temperature rises rapidly.

**Heat Stroke**—Increased body temperature, if uncontrolled, may lead to delirium, convulsions, coma, and even death. Heat stroke is a much more serious condition than either heat cramps or heat exhaustion.

**Hyponatremia**—Low sodium level in the blood, a condition caused by the over consumption of water. Symptoms include feeling weak and fatigued, which may progressively get worse as the sodium level declines. In severe cases, patients may experience seizures and loss of consciousness.

**Rest**—Minimal physical activity, and should be accomplished in the shade, if possible. Any activity requiring only minimal physical activity can be performed during “rest.” Examples are classroom type training, paperwork, minor maintenance on vehicles or weapons, and personal hygiene activities.

**Sortie**—One sortie equates to stepping from Ops, going to the jet, flying, and returning to Ops (Ops-jet-fly-Ops).

**Timing**—Begins when exiting air-conditioned environment (ops, life support, step van with a/c). Time is cumulative on the flight line while outside air-conditioned aircraft.

**Wet Bulb Globe Temperature (WBGT) Index**—The WBGT index is a combination of temperature measurements which considers dry air temperature, relative humidity, and radiant heating. The equation for the WBGT index uses dry bulb, natural wet bulb, and black globe temperatures.

## Attachment 2

**WORK AND REST CYCLES FOR OCCUPATIONAL HEAT EXPOSURES**

**A2.1. Guidelines for Planning Outdoor Work and Rest Regimen for Occupation ally Exposed/ Unprotected Workers.** Refer to paragraph 4.5. for requirements.

**A2.2. Permissible Heat Exposure Limits.** Table A2.1 is extracted from the ACGIH TLV booklet. Limits in the Table A2.1 are based on the following assumptions:

A2.2.1. Personnel are assumed to be acclimated, fully clothed, with average water and salt intake.

A2.2.2. Personnel can take breaks to prevent becoming overheated.

A2.2.3. Exposure limits are based on personnel working in normal work clothing. Exposure limits for personnel working in heavy, restrictive, or impermeable clothing will be reduced 10 °F from the values shown.

**Table A2.1. Permissible Heat Exposure Limits. (Values given in °F WBGT)**

Work and Rest Regimen (per hour)	Work Load (see note)		
	Light	Moderate	Heavy
<b>Continuous Work</b>	86	79.9	77
75% Work/25% Rest	87	80.0 – 81.9	78
50% Work/50% Rest	89	82.0 – 84.9	85
25% Work/75% Rest	90	85.0 – 87.9	86
Mission Critical & 25% Work/72% Rest		88.0 and above	

See Attachment 1 for definition of rest.

## NOTES:

## 1. Examples of workloads:

- a. Light Work: e.g., sitting or standing to control machines performing light hand/arm work.
- b. Moderate Work: e.g., walking about with moderate lifting and pushing.
- c. Heavy Work: e.g., pick and shovel work.

## Attachment 3

**FIGHTER INDEX OF THERMAL STRESS (FITS) CHART**

**A3.1. FITS for Flying Personnel.** See paragraph 5.

**A3.2. FITS Zone and FITS Value.** Enter with local dry bulb (DB) temperature and dewpoint temperature. At intersection, read the FITS zone and the FITS value in °F.

**Table A3.1.**

		Dewpoint Temperature (°F)									
		30	40	50	60	70	80	90	100	110	120
Dry Bulb Temperature (°F)	70	70	73	76	81	86					
	75	73	76	80	84	89					
	80	77	79	83	87	92	98				
	85	80	83	86	90	95	101				
	90	84	86	89	93	98	103	110			
	95	87	89	92	96	101	106	112			
	100	90	92	95	99	103	109	115	121		
	105	93	95	98	102	106	111	117	124		
	110	96	99	101	105	109	114	120	126	133	
115	100	102	104	107	112	116	122	129	135		
120	103	104	107	110	114	119	125	131	138	145	

Above Saturation Temperature

LEGEND

Caution Zone	
Danger Zone	
Cancellation	

**Notes:**

1. Caution Zone:

- 1.1. Be aware of heat stress.
- 1.2. Limit ground operations outside an air-conditioned environment to 90 minutes maximum.
- 1.3. Minimum of 60 minutes recovery time in an air-conditioned environment between sorties/sortie attempts.

2. Danger Zone:

- 2.1. Cancel low-level flights/pattern-only sorties (below 3000 ft AGL).
- 2.2. Limit ground operations outside an air-conditioned environment to 45 minutes maximum.
- 2.3. Minimum of 60 minutes recovery time in an air-conditioned environment between sorties/sortie attempts.

3. Cancellation:

- 3.1. When FITS value is greater than 115, cancel all nonessential flights.